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ABSTRACT

Intended to investigate children's competence in producing verbalizations to aid learning, this study deals with young children's ability to generate sentences, either covertly or overtly, with concurrent relevant motor activity. Sixty children at each of two age levels--four years and seven years--were employed as subjects. It was hypothesized that covert sentence generation among the four-year-olds would be facilitated by the opportunity to engage in concurrent relevant motor activity, and it was further predicted that overt sentence generation would be hindered by concurrent motor activity among the four-year-olds but not among the seven-year-olds. The hypotheses were not supported by the recall score data which showed small differences in favor of the manipulation groups within both age levels and under all verbalization instructions. (Author/RB)

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Technical Report No. 207

AN INVESTIGATION OF THE INTERACTION OF MOTOR ACTIVITY AND SENTENCE PRODUCTION IN YOUNG CHILDREN

Report from Project on
Children's Learning and Development

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* Hays, W. L. Statistics for the Social Sciences, 2nd Edition, N.Y.: Holt, 1973, p. 385.

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Abstract

The present study deals with young children's ability to generate sentences, either overtly or covertly, with concurrent relevant motor activity. Sixty children at each of the two age levels, 4 years and 7 years, were employed as subjects.

Based on statements made by Piaget and by Vygotsky that young children are not capable of producing language covertly and on contentions of Piaget that, at the time of its first appearance, the child's symbolic activity is rooted in his sensorimotor activity, it was hypothesized that covert sentence generation among the 4-year olds would be facilitated by the opportunity to engage in concurrent relevant motor activity. Sentence production for 7-year olds was expected to be less affected since covert language production is believed to be available for children of this age.

It was further predicted that overt sentence generation would be hindered by concurrent motor activity among the 4-year olds but not among the 7-year olds. These hypotheses were based on the findings of Luria and other researchers which indicate that overt verbalization and motor activity are not compatible for young children but that this incompatibility diminishes with older (7-year old) children.

A paired-associate (PA) learning task paradigm was employed with

children's toys used as the PA items. The six treatment groups at each of the two age levels consisted of three verbalization instructions--overt sentence, covert sentence, or covert naming--under either manipulation or no manipulation instructions. Children were instructed to generate interactions between the pair members by manipulating the toys behind a screen and/or by producing sentences. Measures of PA recall, sentence quality, and quality of manipulations were obtained.

The hypotheses were, in general, not supported by the recall score data which showed small differences in favor of the manipulation groups within both age levels and under all verbalization instructions. The sentence ratings data, however, supported the hypothesis that sentence quality would be poorer when both overt sentences and manipulations were requested. Poorer sentence production was found at both age levels, and contrary to the predictions, under covert sentence instructions as well as under overt sentence instructions. These findings are discussed in terms of other studies in which evidence of verbal-motor interaction was found. Tikhomirov's suggestions that the same central processes may be involved in the planning of both the verbal and the motor responses creating a division of effort are also discussed in terms of the present data.

From the present data it appears that children as young as 3 1/2 to 4 1/2 years of age are capable of generating sentences covertly if given the appropriate instructions. This contradicts previous statements regarding the inability of young children to do so.

Chapter 1

Introduction and Review of Literature

Among the many purposes language serves for the adult are social communication and self-guidance. The use of language for these purposes makes possible functioning on a more abstract and efficient level than would otherwise be possible.

The acquisition of language in the young child, however, does not immediately suppose the acquisition of the various functions. While the speech of the child of three or four years is relatively sophisticated, in terms of syntax and vocabulary, the purposes which it serves are apparently limited. Language for communication is quite effective although there are some deficiencies here as shown in Piaget's (1955) studies of "egocentric speech." A more pervasive deficiency is shown in the area of self-guidance by language. (Self-guidance here refers broadly to verbal planning of activities, verbal mnemonic strategies, etc.) The use of language for these purposes appears somewhat later in the child's development.

There are a number of learning situations where verbalization strategies, either overt or covert, have a markedly facilitative effect in learning. While older children and adults tend to employ such strategies spontaneously (e.g., Bower, 1971; Rohwer, 1972) the young child, it seems, does not employ these strategies (Conrad, 1971; Flavell, 1970). Flavell has characterized this failure to employ such a strategy spontaneously when there is a clear ability to do so as a "production deficiency." This term, however, applies only to the case where the child is given no specific instructions to verbalize.

In the present study questions revolve around the child's

competence in producing verbalizations to aid learning where such specific instructions are given.

Imagery & Language

Piaget (1962; and Inhelder, 1969) has maintained that the representational activities of the young child are different manifestations of a more general underlying process referred to as the "semiotic" or "symbolic function." These forms of representation, language, mental imagery, graphic imagery (drawing), symbolic play, and deferred imitation, although intuitively quite different, all serve the purpose of representing objects and events and are seen to appear almost simultaneously in the child's development. Piaget sees these activities as having their common source in the child's motor activity, particularly motor imitation.

The first appearance of representational activity occurs at the end of the period of sensorimotor operations around 1 1/2 to 2 years of age. These symbolic processes continue to develop through the period of preoperational thought to the beginning of the period of concrete operations around age 7.

During this period, the representational processes depend on the child's concrete activity since the mental operations on which they will later be structured are not developed until the period of concrete operations.

There are certain parallels in Piaget's treatment of language and imagery. Clearly they differ in form, language being a conventional symbol system imposed from the outside and imagery a private system of symbols. At the same time, however, in terms of their developmental

history and the child's use there are similarities. Although language is a conventional system of symbols already existing apart from the child, he actively constructs language for his own use. Words, for example, which signify concepts for the adult do not have this breadth of meaning for the child. They are for the child "preconcepts" which are somewhere between the individual symbol and the collective sign (Piaget, 1962, pp. 224-229). Thus although language is a social system of arbitrary signs, for the child, they are much more personal in function, as are images.

The appearance of language and imagery at the end of the period of sensorimotor operations is according to Piaget "almost simultaneous" (Piaget and Inhelder, 1969, p. 53). Furthermore, both language and imagery are influenced by the development of concrete operations and are structured by them. The child then becomes capable of anticipating transformations in his imagery generation (Piaget and Inhelder, 1971) and of employing certain syntactic structures not previously available (Sinclair-de-Zwart, 1967, 1969).

More important for present purposes both language and imagery are seen to be related to the child's motor activity in their early developmental stages. Imagery is ". . . an internalized imitation, one that can be made without resort to external gestures, though it is at first associated with such gestures . . ." (Piaget and Inhelder, 1967, p. 40). With regard to language, Piaget states that at the beginning of the preoperational period ". . . language in the process of construction ceases to be merely an accompaniament to an action in progress, and is used for the reconstitution of a past action, thus providing a beginning of representation. The word then begins to

function as a sign, that is to say, it is no longer merely a part of the action, but evokes it . . . But the verbal account is still only the reconstitution of an action." (Piaget, 1962, pp. 222-223).

From these parallels it might be expected that language production among young children would benefit from the same kind of manipulation as does imagery production.

Based on predictions from Piagetian theory Wolff and Levin (1972) studied the development of mental imagery in the child, utilizing a paired-associate learning task. It has been well demonstrated that instructing a subject to generate an image of pair members interacting facilitates performance among older children, i.e., beyond the pre-operational stage (Bower, 1971; Levin, 1972), but not necessarily among younger children (Montague, 1970). Wolff and Levin reasoned that if, as Piaget argues, imagery generation is an internalized motor imitation, then providing an opportunity for the child to engage in relevant motor activity should facilitate imagery generation and, consequently, paired-associate learning performance. The results of Experiment I of this study indicate that simple imagery instructions facilitate performance among third grade children but not among kindergarten children. Imagery instructions plus the opportunity to manipulate the pair members, however, facilitates performance among both kindergarten and third grade children. In Experiment II of this study and in a subsequent study (Wolff, Levin, and Longobardi, 1972), manipulations were performed "blind," i.e., behind a screen. Similar findings of facilitation in these experiments further demonstrate that facilitation is due to the influence of the motor activity per se rather than to the visual feedback from the manipulated interaction. Moderate correlations (average

r = .325) were reported between manipulation ratings and recognition performance. Thus it can be inferred that relevant motor activity makes possible imagery generation not possible without this activity.

The work of several authors suggests a similar inability to produce sentences in such a task situation before but not after the beginning of the concrete operational period. Jensen and Rohwer (1965) studied the ability of children aged 5 to 17 to benefit from sentence generation or naming instruction. Both a paired-associate and a serial learning task using pictures of objects were employed. In terms of the number of trials and total time needed to reach a criterion, five year olds exhibited no differences in performance between the sentence generation and naming instructions on either task. Among the older children (7 to 17 years), however, marked facilitation was shown under sentence instructions relative to naming instructions on the paired-associate task. In fact, under these instructions the seven year olds performed virtually as well as the seventeen year olds. The authors concluded that the difficulty was due to the fact that the five year olds had difficulty in constructing interacting sentences. They state " . . . although children in this group are able to utter sentences in their ordinary conversation, many of them seemed unable to construct sentences on call as it were. When confronted with the task of making up a sentence containing the names of two pictures, many of the kindergarten Ss connected the two nouns only by the conjunction and, as in 'the cow and the ball.'" (Jensen and Rohwer, 1965, p. 608).

Horowitz, Lampel, and Takanishi (1969) report a similar finding for three and a half to four year old children. The children in this study had difficulty producing sentences to describe a pictured interaction

presented by the experimenter.

Montague (1970) also reports a study of paired-associate learning under varying elaboration instructions. Seven year old children served as subjects in this experiment. Three kinds of mediation instructions, interacting images, interacting sentences, or naming of pair members, were used and subjects were either supplied with mediators or asked to generate their own. In addition, a no mediation instructions control group was employed. Either imposed images or imposed sentences facilitated performance relative to no mediation instructions, but imposed names did not. Of the subject-generated mediators, only the sentence generation group showed facilitation. These findings suggest that ability to generate images appears later than ability to generate images appears later than ability to generate sentences. They are also consistent with the findings of Jensen and Rohwer in demonstrating that seven year olds show improved paired-associate learning performance under sentence generation relative to naming instructions.

Based on this evidence, McCabe, Levin, and Wolff (1973) investigated paired-associate learning under sentence generation instructions with nursery school (4 to 5 year old) children. From the Wolff and Levin (1972) findings it was expected that allowing the child to manipulate the pair members while producing the interacting sentences would facilitate sentence generation and so paired-associate learning performance. Children younger than those employed in the Wolff and Levin and Wolff et al. (1972) studies were employed here on the basis of the Montague evidence that sentence generation ability appears earlier than imagery generation ability. As in the Wolff and Levin

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study, the objects used for the task were common children's toys. Contrary to the predictions, no reliable difference was found between learning performance in the condition where children were instructed to manipulate the objects while producing their sentences and that where sentences were requested without manipulation. Even more surprising was the finding that sentences produced in the sentence plus manipulation condition were rated poorer than in the sentence only condition (mean ratings 7.0 and 9.8 out of 12, respectively). In contrast to the Jensen and Rohwer (1965) finding, children in this study had no difficulty in producing sentences. The authors suggested that this discrepancy might, in part, be due to the difference in materials used in the two studies. In the Jensen and Rohwer study pictures of objects were used, as opposed to actual objects in this study. It is possible that objects are more "sentence-evoking" than are pictures. It was further suggested that requesting the child to generate sentences and motor interactions simultaneously may have produced a "conflict" situation for the child since both are, in fact, overt motor acts. Requesting the child to produce his sentences covertly rather than overtly might provide a fairer test of the hypothesis since imagery generation is a covert process.

Covert Verbalization

Piaget states concerning covert verbalization, "Apart from thinking by images or autistic symbols which cannot be directly communicated, the child up to an age as yet undetermined, but probably somewhere about seven, is incapable of keeping to himself the thought which enter his mind . . ." (Piaget, 1955, p. 59). In a later book (Piaget,

1962) this age estimate is revised downward somewhat to around age five. One observes as a result of this inability to interiorize language frequent monologues and collective monologues among young children.

Vygotsky (1962), although taking issue with much of Piaget's position, also maintains that the child does not become capable of internalizing language until school age (around seven years of age). It is only at this time that speech-for-self becomes fully separated from speech-for-others and "goes underground" in Vygotsky's terms.

There have been few attempts at investigating this supposed absence of covert language in young children. Using a paired-associate learning paradigm with second and fifth grade children, Levin, Davidson, Wolff, and Citron (1973) found that instructions to generate covert sentences of the pair members interacting facilitated performance essentially as well as did instructions to generate images of the pair members interacting. The results indicate that at least by 7 or 8 years of age, the child is capable of benefiting from a covert sentence generation strategy.

There has not been any similar study involving covert sentence generation reported in which younger children were used as subjects. Several studies are reported, however, which deal with young children's ability to profit from covert labeling and covert verbal rehearsal.

Kingsley and Hagen (1969) employed nursery school aged children as subjects in a serial recall task. Subjects who were required to rehearse the stimuli overtly showed improved performance on the early serial positions relative to subjects who were required only to name stimuli covertly or overtly. The rehearsal group was required to repeat the entire sequence of previously presented items after the

presentation of each new item. The naming groups were only required to recite the name of each item as it was presented. Subjects who labeled overtly but did not rehearse stimuli equaled the performance of the rehearsal group on the later serial positions. Subjects instructed to name stimuli covertly performed no better at any serial position than control subjects for whom no labels were available. The authors conclude on the basis of the results that children in this age range do not spontaneously rehearse but that if rehearsal is induced performance is improved.

Flavell, Beach, and Chinsky (1966) report a similar lack of spontaneous covert rehearsal among their kindergarten subjects on a serial learning task. Covert rehearsal in this study was defined as inaudible lip movements, read and classified by one of the experimenters. There was observed in this study, an increase in rehearsal with second grade and especially fifth grade subjects.

Conrad (1971) attempted to trace the development of covert speech in children. The task involved matching pictures of objects. One set of pictures was placed face up before the subject while a subset of identical pictures was presented and then turned face down. The subject's task was to place the pictures in the subset correctly in correspondence with the full set. Two lists were used, one comprising pictures of objects with homophone labels (e.g., cat, bat, hat), the other with non-homophone labels (e.g., bus, girl, spoon). Previous research (Baddeley, 1966; Conrad, 1963) shows that covert verbalization of the labels hinders performance with the homophone list but not the non-homophone list. The results show that before a mental age of five years, subjects perform equally well (or poorly) on the two lists.

After a mental age of five years there is an increasing improvement in performance on the non-homophone list relative to the homophone list with increasing age. The author concludes that the differential performance is due to verbal coding among the older but not the younger subjects.

It seems reasonably safe to conclude on the basis of the Flavell, et al. (1966) and Conrad (1971) studies that the young child does not spontaneously use covert speech to aid his learning. Support for this position can also be drawn from a quite distinct group of studies on verbal mediation (Kuenne, 1946; Kendler and Kendler, 1959) in which it is found that verbalization is not employed by the child younger than about five but that among older children verbalization (generally covert) becomes increasingly more prevalent.

These studies on covert verbalization in young children leave some interesting questions unanswered. While it is quite evident that the young child generally does not spontaneously employ a verbalization strategy in learning situations where it would be beneficial, it is not clear that he cannot if instructed to do so. The McCabe, et al. (in press) study demonstrates that four year olds can employ an overt verbalization strategy given appropriate instructions.

An especially interesting study on this question is reported by Keeney, Cannizzo, and Flavell (1967). First grade subjects were divided into "producers" and "non-producers" of verbal rehearsal based on the Flavell, et al. (1966) criteria. As in that study producers performed better than non-producers on the serial learning task. In a second session non-producers were given instructions and practice in a whispered rehearsal strategy. During the experimental session,

subjects were reminded to rehearse whenever necessary. With the use of this rehearsal strategy the former non-producers performed as well as the producers. Subsequently, three more trials were run where subjects were explicitly given the option of continuing or not continuing the rehearsal strategy. Here the majority of the original non-producer group returned to no rehearsal with a concomitant drop in performance. Clearly, it is not safe to infer that what a child does not do spontaneously in an experimental setting, he cannot do if instructed.

Overt Verbalization and Motor Activity

Levina (cited in Zaporozhets, Zinchenko, and Elkonin, 1971) discusses the relationship between speech and overt problem solving behavior in the young child. She finds that at three or four years of age the child's speech interferes with his problem solving, even though the speech is supposedly directed toward the problem solving. Following this initial stage, speech follows the action and describes it and at a still later stage precedes activity and provides a plan for it. There is then a stage when overt verbalization and motor activity are apparently incompatible.

A similar finding is reported by Meacham (1972) using a somewhat different task. Subjects in this experiment were requested to ride a tricycle following commands, "go," "stop," "back," "up," given by the experimenter. Continuous recordings were made of the subjects' verbal and motor activity, including the rate of the child's ongoing motor activity. Children from three age levels (approximate mean ages, 3 1/2, 4 1/2, 5 1/2 years) participated in the experiment. Half the subjects from each age level were required to repeat the commands after

the experimenter (verbal group) while the other half were not (non-verbal group).

For subjects in the two younger age groups, verbal activity was found to interfere with ongoing motor activity. However, the nature of the interference differed in these two groups. The recordings were divided into intervals and considered in terms of verbal activity during the interval in which the subject was to repeat the verbal command and in terms of motor activity during the immediately following interval in which the subject was to execute the command.

Considering first the subjects' verbal activity during the appropriate interval, the youngest subjects (3 1/2 years) in the verbal group were less likely to engage in verbal activity than were subjects in the two older verbal groups. They less frequently repeated the verbal commands as instructed.

This finding combined with the results regarding the frequency with which the subjects engaged in motor activity during the interval following the verbal command is particularly interesting. At the youngest age level, subjects in the verbal group were more frequently engaged in motor activity than were subjects in the non-verbal group. This combination of findings suggests, according to the author, that "S can engage in either the verbal or the motor activity but not both. The attempt to engage in verbal activity, however, may increase the rate of concurrent motor activity." (p. 42)

For the middle age group the motor pattern is reversed. At this age subjects in the verbal condition are less frequently engaged in motor activity at the beginning of the interval following the verbal command than are subjects in the non-verbal condition. These subjects,

then, more frequently repeat the verbal command as instructed but with the effect of depressing the motor activity. The oldest age group exhibits no such difference between verbal and non-verbal groups in frequency of engaging in motor activity.

These findings suggest an incompatibility of verbal and motor activity for three and four year old children in which there is a dominance of one type of activity. For the three year olds, the motor activity appears to dominate, for the four year olds the verbal activity appears to dominate. The incompatibility is then resolved by the time the child reaches five and a half.

Luria (1961) has shown in his well-known bulb press experiments that by the age of 3 to 4 years the child is able to regulate his bulb pressing activity by the motor aspect of his speech. Without speech accompaniment, the child perseverates in the activity and is apparently unable to regulate it. Wozniak (1972, 1973) in discussing Luria's findings points out that the speech activity follows the initial bulb press response and thereby inhibits perseveration. He states " . . . Luria was discussing a feedback effect of speech on an already active and, in fact, perseverating motor response which reflected back on the response to conflict with with and inhibit it" (1973, p. 6).

Further evidence of "conflict" between speech and motor activity comes from the McCabe, et al. (in press) study discussed above. It will be remembered that sentence production in their sentence plus manipulation condition was poorer than in the sentence only condition.

Rationale for the Present Research

Despite the evidence that the young child does not verbalize in many learning situations where it would be appropriate and facilitative, several studies (e.g., Keeney, et al., 1967; McCabe, et al., in press) indicate that he can do so if instructed. While these studies are concerned with verbalization that is in varying degrees overt, the same questions may be asked with regard to covert verbalization.

While it has been maintained (Piaget, 1962; Vygotsky, 1962) that the child younger than 5 to 7 years of age is not able to internalize language, this assumption remains empirically unverified. It is the purpose of the present study to investigate the young child's ability to verbalize under conditions believed optimum.

Piaget (1962; and Inhelder, 1969) has maintained that the "symbolic function," of which language and mental imagery are different manifestations, has its base in sensorimotor activity. He has also outlined the early connections between language and overt motor actions as discussed earlier. It has also been observed by Bloom (1970) that the child's very early speech takes place only in the context of action. Action, then, appears to provide the necessary context for speech at its first appearance. If this is true of the child's early overt verbalization, then the question arises as to whether this same path might be followed by the child's covert verbalization which is seen to develop somewhat later.

Wolff and Levin (1972) have demonstrated the imagery generation is made possible by providing an opportunity for relevant motor activity at an age where it is not otherwise possible. Since language and imagery as viewed by Piaget are supposedly realizations of a common

underlying process, it is expected that they should react similarly to similar experimental manipulations. It is expected that the child will be able to generate covert sentences given the opportunity for relevant motor activity at an age where he is not otherwise believed to be able to do so.

Since paired-associate learning is aided by generating sentences of pair members interacting, performance on such a task permits inferences about whether sentences were, in fact, generated. The following predictions are, therefore, made:

1) Under instructions to generate covert sentences of pair members interacting, subjects who are permitted to actually manipulate the pairs will be better able to generate sentences and consequently score higher on the paired-associate test than subjects not permitted such manipulation.

2) Since covert sentence generation is available to the older child, the opportunity to manipulate pair members will be less influential for sentence generation than for the younger child. Consequently, paired-associate test performance under manipulation vs. no manipulation conditions will differ less for older children than for younger children.

Among young children the generation of overt verbalization concurrent with other overt motor activity appears to produce a conflict situation in which either the motor or the verbal activity is disrupted (Levina, in Zaporozhets et al., 1971; Luria, 1961; McCabe et al., in press; Meacham, 1972). The same conflict is not found among older children who have become able to coordinate these activities. It is, therefore, further predicted that:

3) Overt sentence production with concurrent manipulation will be more difficult than overt sentence production without concurrent manipulation because of the conflict produced. The paired-associate performance will be correspondingly affected.

4) Since this double production conflict finds its resolution in the older child, sentence and motor productions will be less disrupted at the older age level than at the younger. Paired-associate test performance under manipulation vs. no manipulation conditions will differ less for the older than for the younger age group.

Three minor hypotheses will also be tested. Since overt verbalization is certainly a more familiar form of verbalization for young children than is covert, it should be generally easier to produce. Therefore, it is expected that:

5) Performance in the overt sentence conditions will be better overall than in the covert sentence conditions.

This situation is more true for younger than for older children. While covert verbalization is believed to be nonexistent among children younger than 5 to 7 years, it is believed to be available for children older than this age even though overt verbalization is probably still more prevalent. Thus it is predicted that:

6) There will be less difference between the overt and covert sentence conditions among the older children than among the younger children.

Finally, on the basis of common results on this kind of task (e.g., Jensen and Rohwer, 1965) it is predicted that:

7) Over all experimental conditions, the performance of older children will be superior to that of younger children.

Two control conditions are included in the present study to provide baseline estimates of performance under no sentence generation conditions. Both manipulation and no manipulation conditions with no sentence instructions were included to provide appropriate no sentence comparison groups for the manipulation and no manipulation sentence groups.

Rather than a no verbalization control instruction, a covert naming instruction was decided upon. There are several reasons for this choice. In using a control condition, particularly with young children, one must insure as much as possible that the child's attention is maintained so that any differences between control and other experimental conditions cannot be attributed to a simple failure to attend to the stimuli. In the present study this is particularly the case for the no manipulation control group. It was felt that asking the child to repeat the names of the stimuli would maintain attention. At the same time, it has been shown (Davidson, 1964; Davidson and Dollinger, 1969) that simply naming pair members does not especially facilitate paired-associate learning. The naming instruction also provides some assurance that the child is not spontaneously employing a more effective elaboration strategy, e.g., generating sentences.

Covert rather than overt naming was chosen since overt naming, as well as overt sentence generation, is in fact a motor activity and thus would be expected to produce the same kind of conflict as overt sentence generation in the manipulation condition. In this situation it would not provide the desired control comparison group.

It was decided that the subject's manipulations of pair members should be screened from his view so that children in the manipulation

conditions would not be provided with visual feedback from the manipulations. This feedback would constitute imposed interacting images previously shown to facilitate paired-associate learning even without sentence generation (Davidson and Adams, 1970; Levin, 1972). This visual feedback would not have been available to subjects in no manipulation conditions and would have confounded the results.

Age is considered to be an important variable. The evidence suggests that covert verbalization is not available to the child younger than 5 (Piaget, 1962) to 7 (Vygotsky, 1962) years but is available to children older than 7 years. The younger children for the present study should then be younger than 5 years of age since it would be agreed that for these children covert verbalization would not be available. The older children should be at least 7 years of age since, again, it would be agreed that for these children covert verbalization would be available.

With regard to the conflict produced by the attempt to produce overt verbalization concurrent with other overt activity, Meacham (1972) found conflict in 3 to 5 year old children and Levina (in Zaporozhets, et al., 1971) found conflict among 3 to 4 year old children. Meacham also found evidence of a reduction in conflict among 5 to 6 year old children. In the Levina study the age at which conflict is no longer present is not noted.

For this question, then, the younger age children should be within the 3 to 5 year age range and the older children should be older than 5 years. On the basis of these requirements, the ages selected were 4 and 7 years.

Chapter 2

Method of Investigation

Design and Analysis

The design of the present study is a completely crossed and balanced 3 x 2 x 2 factorial design with the variables, verbalization instructions, motor-manipulation, and age.

The following experimental conditions were employed:

Overt Sentence Plus Manipulation--Subjects were asked to make one toy do something to the other toy and at the same time to tell a story about what they were doing.

Overt Sentence with No Manipulation--Subjects were asked to tell a story about one toy doing something to the other toy. No manipulation of toys was permitted.

Covert Sentence Plus Manipulation--Subjects were asked to make one toy do something to the other toy and at the same time to think of a story about what they were doing but to keep the story a secret.

Covert Sentence with No Manipulation--Subjects were asked to think of a story about one toy doing something to the other toy but to keep the story a secret. No manipulation of the toys was permitted.

Covert Naming Plus Manipulation--Subjects were asked to make one toy do something tc the other toy and at the same time to think of the names of the toys but to keep the names secret.

Covert Naming with No Manipulation—Subjects were asked to

think of the names of the toys but to keep the names a secret. No manipulation of the toys was permitted.

These six conditions were repeated for children of two age levels, four year olds and seven year olds.

Performance on the paired-associate test, i.e., number of response members of pairs correctly recalled, served as the basic dependent measure. The four major and three minor hypotheses were tested by means of planned orthogonal comparisons. Type I error probability was set equal to .05 for the major hypotheses and .01 for the minor hypotheses. Different error probability levels were chosen so that approximately the same power ($1 - B = .90$) would be available for testing each of the null hypotheses against its alternative (Levin, 1973). In addition, each of the sentence production groups was compared with its appropriate naming control group by means of a Dunnett procedure (Dunnett, 1955) with α set equal to .05.

Three additional dependent measures were collected. Following the learning and test trials on the paired-associate task, subjects were asked to reproduce the sentences generated during the learning trial (for subjects in the sentence conditions) or to generate sentences for the pairs of toys (for subjects in the naming conditions). These post-experiment sentences were available for all subjects. The remaining two measures were the sentences and motor interactions produced during the learning trial. These measures were available only for subjects in the overt sentence and manipulation conditions. While these measures were not included in the major analysis of the data, comparisons among them provided additional evidence regarding the processes under investigation.

Subjects

One hundred and twenty children, 60 at each of the two age levels, served as subjects for this experiment. Subjects in the younger age group were recruited from 2 nursery schools and 2 day care centers in Watertown and Madison, Wisconsin. The mean age for this group was 50.2 months (4 years 2 months) with a range from 3 years 7 months to 4 years 9 months. Subjects in the older age group were recruited from the first grade classes of an elementary school in Oconomowoc, Wisconsin. The mean age for this group was 85.3 months (7 years 1 month) with a range from 6 years 9 months to 7 years 6 months. There were approximately equal numbers of boys and girls in the two age groups (32 boys and 28 girls in the younger group and 30 boys and 30 girls in the older group). Subjects within each age group were randomly assigned to the six treatment conditions. There were no significant differences in age among the treatment groups ($F < 1$ for each group). Mean ages and standard deviations for the treatment groups are given in Table 1.

Materials

The materials for the paired-associate task were 24 common children's toys, e.g., a plastic telephone, a metal truck, a wooden rolling pin. The toys varied in size from 2 inches to 8 inches on the longest dimension. All toys were easily labelable by the subjects. The paired-associate list was formed by pairing the toys such that an interaction between them was plausible but not obvious. See Appendix A for the list of pairs.

During the experiment, the toys were kept out of the signt of the subject until they were presented in the learning task. A cardboard "stage" was also used during the experiment to screen the subject's motor

Table 1. Means and standard deviations of ages (in months) for treatment groups.

		Overt Sentence		Covert Sentence		Covert Names	
		Manipulation	No Manipulation	Manipulation	No Manipulation	Manipulation	No Manipulation
4 year olds	$\bar{X}$	49.00	50.30	50.30	50.50	50.40	50.90
	S.D.	4.97	3.16	4.58	4.22	4.20	3.80
7 year olds	$\bar{X}$	85.40	85.30	84.90	85.60	85.70	85.00
	S.D.	2.15	2.57	2.46	2.20	2.79	2.04

manipulations of the pairs from his view. The stage was constructed from a cardboard box 17 inches wide, 12 inches high, and 11 inches deep. The back of the stage (the side facing the experimenter) was left open to permit observation and recording of the child's motor manipulations. An opening 12 inches wide and 9 inches high was cut in the front of the box and covered by a cloth curtain. The box was decorated to look like a stage. A Uher Universal 5000 tape recorder was used to record the subject's verbalizations.

Procedure

Subjects were tested individually in rooms separate from their regular classrooms. Upon entering the room, the child was seated at a low table across from the experimenter and slightly to her left. The experimenter instructed the child during the experiment and presented the toys in the paired-associate learning and test phases of the experiment. A second experimenter was seated to the left of the first. The second experimenter operated the tape recorder and also recorded the motor manipulations produced by the child. The stage was placed on the table midway between the two experimenters and slightly to the child's right.

After the subject was seated he was told he was about to "play a game with some toys" and the instructions appropriate for his experimental condition were given. (For a sample set of complete instructions see Appendix B). Each subject was given three practice pairs. For the first practice pair the toys were kept in the subject's view during his motor and/or verbal production. Verbalizations for this pair were overt. If the subject failed to produce an interacting sentence and/or

manipulation, the experimenter provided an appropriate example. The stage was introduced for the second practice pair. Subjects were told that this was a place the toys could do things in. Subjects in the motor involvement conditions were told that from here on they were to make the toys do things in the stage. They were asked to put their hands under the curtain so that the experimenter could hand them the toys. Subjects in the covert sentence and covert naming conditions were told that now they should keep the stories and names a secret. If the subject began to verbalize overtly, he was reminded not to say the sentence or names out loud. Following the presentation of this practice pair subjects in the covert sentence groups were asked to give their stories out loud. If subjects in any of the experimental conditions failed to produce an interaction for the second pair, the experimenter provided an appropriate example. A third practice pair was then presented. If a subject appeared to be having difficulty understanding what he was to do, an additional practice pair was presented.

The paired-associate presentation was begun immediately after the practice session. The order of presentation of the pairs was randomly determined and the same order was used for all subjects. Subjects were told that now they would be shown many towys two at a time and that each time they saw two toys they would be told to make one toy do something to the other toy and/or to make up a story about one toy doing something to the other toy. (Subjects in the Covert Naming - No Manipulation condition were, of course, not given the interaction instructions.)

The instructions were reiterated for each pair that was presented. This was done to ensure that failure to produce an interaction for any

pair was not due to a forgetting of the instructional set. Pairs were presented for approximately 8 seconds each. Since it was decided that a subject should not be interrupted in the midst of a motor or verbal production, some variation in presentation time existed. Four year olds were generally slower in their production of interactions than were seven year olds. The mean presentation time per item was 9.0 seconds for four year olds and 8.3 seconds for seven year olds. Within each age level the mean presentation time per item for each condition varied no more than 0.5 seconds with the exception of the Overt Sentence Plus Manipulation condition for the four year old group. This will be discussed later.

Following the presentation of all 12 pairs a paired-associate test trial was given. Items for the test trial were presented in a different random order than the learning trial and the same for all subjects. The experimenter presented one toy from each pair while the subject attempted to recall the other member. Approximately 10 seconds were allotted for the child to respond.

In the third phase of the experiment subjects in the sentence conditions were asked to recall the sentences produced earlier. Subjects in the Covert Naming Plus Manipulation condition were asked to tell stories about what the toys had been doing before, and subjects in the Covert Naming - No Manipulation condition were asked to make up stories about the toys interacting. For this part of the experiment, pairs were reinstated and presented again in the same order as for the learning trial. Each pair was kept in the subject's view while he recalled his sentence but no manipulation was permitted. This completed the experimental procedure.

Subjects were then presented with an array of trinkets from which they could select one to keep.

Chapter 3

Results

Mean Recall Score Results

The means and standard deviations for each of the age-treatment groups are presented in Table 2. The sources of variance and their mean squares are given in Table 3. Each of the seven hypotheses of interest was tested by a 1 degree of freedom directional test with error degrees of freedom equal to 108. Type I error probability was set equal to .05 for the four major hypotheses and equal to .01 for the three minor hypotheses.

Of the four major hypotheses for the present study, none received empirical support. Hypothesis 1 had predicted that within the covert sentence groups, children permitted to manipulate the toys would score higher on the recall test than children not permitted such manipulation. The advantage of the manipulation over the no manipulation groups was small (0.7 items) and statistically nonsignificant (critical difference = 1.13). Hypothesis 2 had predicted that with covert sentence instruction the manipulation vs. no manipulation difference would be smaller for the seven year olds than for the four year olds. The differences proved to be essentially the same for the two age groups (0.60 and 0.80 for four year olds and seven year olds, respectively) and, if anything, showed a larger difference for the seven year olds.

Hypothesis 3 predicted that within the overt sentence groups, children permitted to manipulate the toys would score poorer on the recall test than those not permitted such manipulation. This differ-

Table 2. Means and standard deviations of recall scores by treatment groups.

		Overt Sentence		Covert Sentence		Covert Names	
		Manipulation	No Manipulation	Manipulation	No Manipulation	Manipulation	No Manipulation
4 year olds	$\bar{X}$	4.20	2.90	3.20	2.60	1.60	1.20
	S.D.	2.70	1.97	2.39	1.90	1.58	0.79
7 year olds	$\bar{X}$	7.30	6.50	7.20	6.40	6.70	1.70
	S.D.	2.06	2.41	1.99	2.99	3.06	0.82
Column means		5.75	4.70	5.20	4.50	4.15	1.45

Table 3. Sources of variance for recall data analysis.

Hypothesis	Source of Variance	d.f.	SS	MS
7	Age (A)	1	262.81	262.81
5	Verbalization (V)	1	2.81	2.81
6	A x V	1	1.48	1.48
	Motor (M)/V	(2)		
3	M/Overt (O)	1	11.03	11.03
1	M/Covert (C)	1	4.91	4.91
	A x M/V	(2)		
4	A x M/O	1	.62	.62
2	A x M/C	1	.09	.09
	Residual	4	337.71	84.43
	Error (within)	108	509.29	4.72

ence (1.05) was statistically nonsignificant (critical difference = -1.14) and in the opposite direction from that predicted. Children in the overt sentence plus manipulation groups scored higher on the recall test than those in the overt sentence with no manipulation. Hypothesis 4 stated that the manipulation vs. no manipulation difference within the overt sentence groups would be smaller for seven year olds than for four year olds. This hypothesis was also not supported by the data (obtained difference = 0.25, critical difference = -1.14).

Of the three minor hypotheses only one was supported by the data. Hypothesis 5 predicted that recall performance of subjects in the overt sentence conditions would be better than that of subjects in the covert sentence conditions. The data failed to support this hypothesis (obtained difference = 0.38, critical difference = 1.13). It was predicted in Hypothesis 6 that the overt vs. covert sentence difference would be smaller for seven year olds than for four year olds. The obtained difference (0.28) is not statistically significant (critical difference = 1.13).

Hypothesis 7 stated that seven year olds would perform better on the recall test than would four year olds. This hypothesis is supported by the data (obtained difference = 3.62, critical difference = 1.13).

Four separate Dunnett tests (each at α=.05) were carried out, comparing each of the treatment groups against its appropriate control group. Comparisons were made within age levels and manipulation or no manipulation groups.

Within the manipulation groups at the four year old level, the overt sentence group scored reliably higher on the recall task than the

naming control group (obtained difference = 2.60, critical difference = 2.03). The difference for the covert sentence group (1.60) did not reach statistical significance. For the seven year olds in the manipulation conditions, neither the overt nor covert sentence groups performed significantly better than the naming control group (obtained differences = 0.60 and 0.50, respectively, critical difference = 2.15).

In the no manipulation groups at the four year old level, the overt sentence group scored reliably higher than the naming control group (obtained difference = 1.70, critical difference = 1.45). The difference for the covert sentence group (1.40) did not reach statistical significance (critical difference = 1.45). For the seven year olds both the overt and covert sentence groups scored reliably higher than the naming control group (obtained difference = 4.80 and 4.70, respectively, critical difference = 2.01).

Mean Sentence Rating Results

The sentences produced during the learning trial (experiment sentences) and those produced after the recall test (post-experiment sentences) were rated for the quality of the interaction they described. An acceptable interaction (scored as 1) was one in which the stimulus toy was acting directly on the response toy in a manner which conformed reasonably well with the properties of the latter, e.g., "The bird talked on the telephone.", "The deer was wearing the watch.". All other responses were unacceptable (scored as 0). The sentences were rated independently by two judges, each of whom was unaware of the age of the subject and the experimental condition in which the sentences were produced. Inter-rater reliability for total

sentence scores for each subject was .878. Each subject's score on sentence production is the mean of the ratings of the two judges. Mean sentence ratings for sentences produced during the learning trial are presented in Table 4. These ratings are available only for subjects in the overt sentence groups. Mean sentence ratings for sentences produced during the third phase of the experiment, following the recall test, are presented in Table 5.

Since the differences predicted for the recall measure should be reflections of sentence production during the learning trial, similar statistical analyses were performed on these data. Predictions for the recall data for the overt sentence groups were also tested on the experimental sentence data. An identical test was performed on these data with the exception that the estimate of error is based on 40 observations (df = 36) here as opposed to 120 observations (df = 108) for the recall data. The prediction that sentence production in the manipulation groups would be poorer than in the no manipulation groups did not reach statistical significance (obtained difference = .92, critical difference = 1.43). This difference, however, is in the predicted direction and approaches significance ($.10<p<.15$) in contrast to the recall test results. The predicted interaction with age was not significant (obtained difference = -.07, critical difference = 1.43).

The post experiment sentence data were also analyzed in the manner of the recall test data. Identical comparisons were made here with the exception that the estimate of error is based on 80 observations (df = 72) for these data. Control groups were not included in the analysis since the sentences for these groups were originally produced during the post recall test phase and not sentences recalled from the learning

Table 4. Means and standard deviations of sentence ratings for sentences produced during the learning trial by subjects in the overt sentence groups (maximum = 12).

		Manipulation	No Manipulation
4 year olds	$\bar{X}$	7.80	8.65
	S.D.	3.16	2.63
7 year olds	$\bar{X}$	8.80	9.80
	S.D.	3.01	1.50
Column means		8.30	9.22

Table 5. Means and standard deviations of sentence ratings for sentences produced during the post-recall phase of the experiment (maximum = 12).

		Overt Sentence		Covert Sentence		Covert Naming	
		Manipulation	No Manipulation	Manipulation	No Manipulation	Manipulation	No Manipulation
4 year olds	$\bar{X}$	7.50	10.60	8.00	10.00	8.95	8.95
	S.D.	2.90	1.00	2.46	2.16	2.07	3.25
7 year olds	$\bar{X}$	8.35	10.15	9.45	9.70	10.35	9.35
	S.D.	2.72	1.13	1.90	.95	2.20	2.05
Column means		7.92	10.37	8.72	9.85	9.65	9.15

trial.

For the covert sentence groups, sentence ratings should be higher in the manipulation relative to the no manipulation conditions. This prediction is not supported by the data since the difference is in the direction opposite that predicted (obtained difference = -1.12, critical difference = 1.07). The predicted interaction with age is also not supported (obtained difference = -.87, critical difference = 1.07) since the main effect difference is in the direction opposite that predicted. There was, however, a smaller mean difference at the seven year old level (-.25) than at the four year old level (-2.00).

Among the overt sentence groups the prediction that the no manipulation groups would exceed the performance of the manipulation groups is supported (obtained difference = -2.45, critical difference = -1.07). The predicted interaction with age is not statistically significant (obtained difference = -1.30, critical difference = -2.15) but again the difference at the seven year old level (1.80) is smaller than that at the four year old level (3.10).

None of the minor hypotheses was supported by the post-experiment data. The prediction that the overt sentence groups would produce better sentences than the covert sentence groups was not supported (obtained difference = -.11, critical difference = 1.09). That this difference would interact with age was also not supported (obtained difference = 0.19, critical difference = 1.09). It was predicted that seven year olds would produce better sentences than four year olds. This difference did not reach statistical significance (obtained difference = .39, critical difference = 1.09) for the post-experiment sentence data.

Mean Manipulation Ratings Results

The manipulated interactions produced during the learning trial were also scored for the quality of the interaction. An acceptable interaction (scored 1) was one which could be interpreted as the stimulus member of the pair acting directly on the response member in a manner conforming reasonably well with the properties of the latter. All other responses were considered unacceptable (scored 0). The manipulations were rated independently by two judges each of whom was unaware of the age of the subject and the experimental condition in which the manipulations were produced. Inter-rater reliability for total manipulation scores for each subject was .917. Like the sentence ratings, each subject's score is composed of the mean of the ratings of the two judges. Mean manipulation ratings for each sentence-age group are given in Table 6. An overall analysis of variance on these data reveals a significant age effect (F = 7.02, df 1/54, $p < .05$). Manipulation ratings for seven year olds were higher than those for four year olds. Neither the verbalization nor the age by verbalization interaction effects was significant.

Correlational Results

For each of the age-treatment groups, a correlation matrix was obtained for the following measures: recall test score, experiment sentence ratings, post-experiment sentence ratings, and manipulation ratings. These matrices are presented in Tables 7 through 9. Since all of these measures were expected to be positively related, directional tests were made. With Type I error probability set equal to .05, the value of the correlation coefficient needed for significance with 8 degrees of freedom is .549. Average correlations based on Fisher transformations are given in Table 10.

Table 6. Means and standard deviations of manipulation ratings.

		Overt Sentence	Covert Sentence	Covert Naming
4 year olds	$\bar{X}$	7.85	7.15	7.25
	S.d.	1.84	3.45	2.82
7 year olds	$\bar{X}$	9.10	9.85	9.50
	S.d.	3.41	1.51	2.08
Column means		8.47	8.50	8.37

Table 7. Correlation matrices for dependent measures in Overt Sentence groups.

Manipulation Groups

	4 year olds				7 year olds			
	Recall	Exptl. Sent.	Post Exptl. Sent.	Manip.	Recall	Exptl. Sent.	Post Exptl. Sent.	Manip.
Recall		.695	.695	.353		-.698	-.709	-.670
Exptl. Sent.			.918	.767			.954	.905
Post Exptl. Sent.				.576				.795

No Manipulation Groups

	4 year olds			7 year olds		
	Recall	Exptl. Sent.	Post Exptl. Sent.	Recall	Exptl. Sent.	Post Exptl. Sent.
Recall		.645	.199		.348	.132
Exptl. Sent.			.555			.775
Post Exptl. Sent.						

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Table 8. Correlation matrices for dependent measures in Covert Sentence groups.

Manipulation Groups					
4 year olds			7 year olds		
Recall	Post Exptl. Sent.	Manip.	Recall	Post Exptl. Sent.	Manip.
Recall	.669	.575		-.114	.215
Post Exptl. Sent.		.367			.663

No Manipulation Groups					
4 year olds			7 year olds		
Recall	Post Exptl. Sent.	Manip.	Recall	Post Exptl. Sent.	Manip.
Recall	.718			-.482	

Table 9. Correlation matrices for dependent measures in Covert Naming groups.

Manipulation Groups					
4 year olds			7 year olds		
	Recall	Post Exptl. Sent.	Manip.	Recall	Post Exptl. Sent.	Manip.
Recall		.299	.512	Recall	.505	.882
Post Exptl. Sent.			.805			.661

No Manipulation Groups					
4 year olds			7 year olds		
	Recall	Post Exptl. Sent.	Manip.	Recall	Post Exptl. Sent.	Manip.
Recall		-.212			.332	

Table 10. Average correlations for dependent measures.

	average r	df	p
Overt Sentence Groups			
Experiment Sentence with Recall	.275	28	>.05
Post Experiment Sentence with Recall	.077	28	>.05
Experiment Sentence with Post Experiment Sentence	.855	28	<.005
Covert Sentence Groups			
Post Experiment Sentence with Recall	.261	28	>.05
Covert Naming Groups			
Post Experiment Sentence with Recall	.244	28	>.05
All Manipulation Groups			
Manipulation with Recall	.379	42	<.01
All Subjects			
Post Experiment Sentence with Recall	.349	84	<.005

While the differences between correlations were not tested, certain trends are apparent. The correlations between experiment sentence ratings and recall are higher for the four year old groups than for the seven year old groups (Table 7). Correlations between post-experiment sentence ratings and recall for the sentence instruction groups (Tables 7 and 8) are generally higher for the four year old groups than for the seven year old groups. The high negative correlations between sentence ratings and recall and manipulation ratings and recall were not expected. They are not consistent with other trends within the present study or within previous studies (e.g., McCabe, et al., in press). The author can offer no reasonable explanation for this discrepancy.

For the covert naming groups (Table 9) correlations between post-experiment sentence ratings and recall are generally low, as would be expected, since no sentence instructions were given before the recall test. On the other hand, correlations between manipulation ratings and recall for these groups would be expected to be higher than for the sentence groups since producing the manipulated interaction is the sole associative strategy suggested. This expectation is supported by the results with the one exception. In the four year old sample, the correlation between manipulation ratings and recall is slightly higher for the covert sentence group (.575) than for the covert naming group (.512).

Chapter 4

Discussion

Recall score data for the present study did not, in general, support the hypothesis. Differences within each of the age groups were relatively small. There were certain trends, however, which because of their consistency merit attention. For both age groups, within each verbalization instruction condition, subjects permitted manipulation scored higher than subjects permitted no manipulation. Among the four-year-old groups variability was also somewhat greater in the manipulation in comparison to the no manipulation conditions. Better performance in conjunction with increased variance may be interpreted as an indication that the condition is facilitative but that the ability under question is only beginning to be acquired at a particular age level. Subjects who have mastered the ability perform well while those who have not yet attained this mastery perform poorly. Low variability would be expected when either all subjects have acquired an ability and perform uniformly well or when none of the subjects have attained it and perform uniformly poorly. On this basis, it would appear that within the four-year-old age level some subjects are beginning to gain recall facilitation from manipulating the objects. The seven year olds also appear to gain some recall facilitation from manipulation, markedly so when not instructed to produce sentences. Although Ss in this latter condition were instructed to name the objects covertly, it is possible that the seven year olds did employ some other strategy when they were permitted to manipulate. Some of these subjects may have spontaneously

generated sentences. Other investigators (Conrad, 1971; Flavell, et al., 1966) have found an increase in spontaneous verbalization among subjects in this general age range.

Another consistent trend within these data is an improvement in performance associated with sentence generation strategies. In all cases, means for sentence generation groups were higher than for the corresponding naming groups. Variability is also generally higher for the sentence generation groups than the naming groups, with the exception of performance in the seven-year-old covert naming manipulation group which was higher than in the corresponding sentence groups.

Comparison of the recall data from the present study with those of Wolff and Levin (1972) and Wolff, et al. (1972) studies reveals that sentence production did not respond to concurrent manipulation in the same way as had been demonstrated for imagery production. It is difficult to interpret this discrepancy on the basis of the present data. The paired-associate test mode for the present study was recall in contrast to recognition tests for the Wolff and Levin studies. The recall test may have been too difficult for the four year olds in this study, thereby depressing performance and masking any differences that might have been found. Since the recall data do not provide the information necessary to answer this question, the bulk of the discussion will center on the sentence and manipulation data.

Since the post-experiment sentence data are being accepted as reproductions of sentences produced during the learning trial, some justification for their validity is in order. For the covert sentence groups there is no direct way of assessing whether this assumption is tenable. It is possible that in the covert sentence groups sentences

were not produced during the learning trial but were only produced for the first time during the post-recall test phase of the experiment. The data that are available, however, attest to their validity. It is possible to test the experiment and post-experiment sentences of the overt sentence groups for agreement. Correlations between total scores on the experiment and post-experiment sentence ratings for subjects within each group are high (average $\underline{r} = .855$). This result is in accord with what would be expected if subjects are reproducing sentences generated during the learning trial.

A more precise measure of agreement between experiment and post-experiment sentences was obtained. Sentences were compared for agreement in general meaning between experiment and post-experiment sentences. Each such pair of sentences was scored as agreeing or disagreeing regardless of the quality of the sentences. The sum of agreements for each subject was obtained and a ratio computed of the number of agreements to the number of experiment sentences actually produced, again regardless of the quality of the experiment sentence. These ratios were averaged across subjects in each of the age-treatment groups. The data are presented in Table 11. Since the percentage of agreements is very high for each group, it is evident that for these subjects, at least, the post-experiment sentences were reproductions of experiment sentences.

A similar measure was computed for agreement between manipulations and experiment sentences for the overt sentence plus manipulation groups and between manipulation and post-experiment sentences for each of the manipulation groups. For this measure an agreement was scored if the sentence could reasonably be interpreted as describing

Table 11. Percent Agreement between Experiment and Post-experiment sentences for Overt Sentence groups.

	Manipulation	No Manipulation	Row Means
4 year olds	.79	.82	.80
7 year olds	.94	.98	.96
Column Means	.86	.90	

the manipulated interaction regardless of the quality of either. Ratios of the number of agreements to the number of manipulations produced were computed. The mean ratios for each age treatment group were obtained. These data are presented in Tables 12 and 13. Again the ratios for each group are quite high, but more important the percentage scores for the covert sentence groups are more similar to those for the overt sentence groups than to those for the covert naming groups. These agreement scores for the sentence groups are also better approximations of the agreement scores for experiment sentences with manipulations than are those for the covert naming groups (compare Tables 12 and 13). In addition, the agreement measures for the sentence groups are higher than for the naming groups. Both of these results would be expected if subjects in the covert sentence groups did produce sentences during the learning trial. It seems reasonable to conclude, therefore, that subjects in the covert sentence groups did produce sentences during the learning trial and that the post-experiment sentences are a fairly accurate representation of these earlier sentences.

Covert Verbalization

It was argued in Chapter 1 that covert sentence production, like imagery, would be facilitated by concurrent motor activity. It was expected that marked facilitation would be found for the younger subjects with the difference decreasing at the older age level. The recall data do not support these expectations but the data are not really conclusive. The post-experiment sentence data suggest more strongly that concurrent manipulation hinders rather than helps covert

Table 12. Percent agreement between manipulations and experiment sentences for Overt Sentence Plus Manipulation groups.

4 year olds	.84
7 year olds	.96*
Column Means	.90**

* based on 9 observations since one S produced no manipulations

** weighted mean

Table 13. Percent agreement between manipulations and post-experiment sentences for manipulation groups.

	Overt Sentence	Covert Sentence	Covert Naming	Row Means
4 year olds	.77	.77	.65	.73
7 year olds	.92*	.87	.83	.87
Column Means	.84**	.82	.74	

* based on 9 observations since one S produced no manipulations

** weighted mean

sentence production. Mean sentence ratings are lower for the manipulation groups at both age levels, although only marginally so at the seven-year level. Since it was predicted that manipulation groups would produce better sentences than no manipulation groups, no statistical test was performed. The difference, however, would have been significant if the prediction had been reversed. In addition, variability in the manipulation groups was higher than in the no manipulation groups. This difference was statistically significant for the seven-year olds ($F = 5.64$, $df = 9/9$, $p < .01$) but not for the four-year olds ($F = 1.30$, $df = 9/9$, $p > .10$). The pattern of mean differences combined with variability differences suggest that concurrent motor activity conflicts with covert sentence production, as well as with overt as found in the McCabe, et al. (in press) study.

Based on the Piaget (1962) and Vygotsky (1972) contentions it was expected that children younger than five years of age would be unable to produce sentences covertly. The post-experiment sentence data indicate that these four-year olds had no difficulty in producing sentences covertly when not permitted to manipulate the objects. The mean sentence rating for this group was 10 of a possible 12. While children of this age may not spontaneously verbalize covertly, it is apparent that they can do so when instructed.

Overt Verbalization and Motor Activity

On the basis of previous results (Luria, 1961; McCabe, et al., in press; Meacham, 1972) it was predicted that within the overt sentence conditions, manipulation would conflict with sentence production. The recall score results did not support this prediction

since recall scores for the manipulation groups were higher than for the no manipulation groups, although not significantly so.

The sentence ratings data present a different picture. As in the McCabe, et al. study, mean sentence ratings were lower in the manipulation groups than in the no manipulation groups. This difference is consistent across both age levels in both the experiment and post-experiment sentence data. For the experiment sentence data the difference (0.92) was not statistically significant ($.10 < p < .15$). Variability among the sentences produced with manipulation was also greater than among those produced with no manipulation. This difference in variability was statistically significant for the seven-year-old age group ($F = 3.96$, $df = 9/9$, $p < .05$) but not for the four-year-old group ($F = 1.44$, $df = 9/9$, $p > .20$).

Post-experiment sentence ratings also show a difference in favor of the no manipulation groups (mean difference = 2.45). The difference here is statistically significant. Variability in the manipulation groups was again greater than in the no manipulation groups for both the seven-year olds ($F = 5.79$, $df = 9/9$, $p < .01$) and the four-year olds ($F = 8.41$, $df = 9/9$, $p < .01$).

These results suggest that a conflict is induced when simultaneous verbalization and motor activity is requested. A further indication of the conflict comes from the longer presentation times for four-year olds in the overt sentence plus manipulation group mentioned in Chapter 2. The reason for the longer presentation times was that these subjects generally executed the motor manipulation before giving the sentence. This is in contrast to the seven-year olds who often began the sentence before initiating the motor manipu-

lation.

These findings along with those of McCabe, et al. (in press) indicate that the verbal motor interaction discussed by Meacham (1972) and by Wozniak (1972) is more pervasive than previously shown. In those studies both the motor activity involved and the verbalization requested were fairly simple and well defined. In the case of Luria's (1961) experiments discussed by Wozniak, the motor response was a bulb press and the verbalization was "go." In the Meacham study, tricycle riding was the motor response and the verbal response was one of four one-word commands. In those studies, also, the child was given explicit instructions as to the particular verbal and motor responses to be produced. This is in contrast to the present study where neither the verbal nor the motor response were explicitly defined. Nevertheless, the interaction of the two kinds of response is apparent.

The different manners in which the two age groups approach the dual production is interesting in light of Meacham's finding that his two youngest groups displayed different patterns of interaction. For the youngest group (3 1/2 years) in his study the request for dual production resulted in an increase in motor activity at the expense of verbal. For his middle age group (4 1/2 years), the request for dual production resulted in a decrease in motor activity while the verbal response was given. In the present study the younger group produced the motor activity first while the older group often began the verbal activity first. While the actual age levels are different, the pattern is much the same. This may be due to the fact that the task in the present study was more difficult.

General Discussion

There are two major findings in the present study. First, it is apparent that children as young as three-and-a-half to four-and-a-half years of age are capable of producing sentences covertly. This is in contrast to statements made by Piaget (1962) and Vygotsky (1962) which contend that internalized language is not available to the child until somewhat later. Previous investigators (Conrad, 1971; Flavell, et al., 1966) have found no evidence of covert verbalization in children five years of age or younger. It must be kept in mind, however, that children in these studies were not expressly instructed to verbalize. It is quite likely that the four-year-old children in the present study would likewise not have generated sentences had they not been so instructed.

Two differences in performance between the sentence groups and the naming groups suggest that this was, in fact, the case. Sentence groups performed consistently better on the recall test than did the naming groups in both the manipulation and no manipulation conditions. In addition, the post-experiment sentence data show consistent differences in favor of the no manipulation group in each of the age-sentence treatment combinations. This pattern does not appear in the covert naming conditions where the sentence ratings are the same for manipulation and no manipulation groups at the four-year-old level and are higher for the manipulation group at the seven-year-old level.

Although the study was not designed for such a purpose, it is tempting to speculate as to whether the poor recall test performance of the four-year-old group might be attributed to "mediational deficiency" as defined by Flavell, et al. (1966). It will be remembered

that a significant age difference was found in the recall test score data but not in the sentence data. From these results it appears that the younger children were producing sentences that were nearly as good as those produced by the older children but that these sentences did not mediate recall as well for the younger groups. The recall scores for the sentence groups among the four-year-olds, however, were higher that those for the naming groups. For the overt sentence groups these differences were statistically significant. A mediational deficiency hypothesis would predict no differences between the sentence and naming groups. Therefore, the present results do not provide clear evidence either for or against such a hypothesis.

The second major finding of the present study deals with the conflict produced by the dual instruction to produce both sentences and motor manipulations. Contrary to the original expectations the effect of dual instruction was found under both the overt and covert sentence instructions. The difference between the manipulation and no manipulation groups is smaller in the covert sentence condition (1.12) than in the overt sentence condition (2.45). The difference, however, would have been significant ($p < .05$) had the direction been predicted (critical value = 1.07).

It was argued in Chapter 1 that a manipulation vs. no manipulation difference would be expected among the overt sentence groups because both overt sentence generation and the manipulation were motor activities. The demand for two motor activities was expected to be the source of the conflict. The present findings may be interpreted as supporting this hypothesis since even in covert sentence generation there may be motor activity involved, i.e., subvocal movements of the speech

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apparatus. The smaller manipulation vs. no manipulation difference under covert sentence production is consistent with such an interpretation if one believes that the conflict should be in proportion to the extent of motor activity involved in the sentence production. It should be noted, however, that the smaller differences in the covert sentence condition are due not only to higher sentence ratings in the covert sentence plus manipulation conditions but also to lower sentence ratings in the corresponding no manipulation condition.

Another interpretation is suggested by the work of Tikhomirov (as cited in Wilder, 1973). Soviet work (Luria, 1961) has demonstrated that among children aged three to four-and-a-half years, perseverative responding in the bulb press experiments can be controlled by the impulsive aspect of the child's speech even though the verbal response follows the bulb press. Wozniak (1973) points out that the verbal response, as another motor response, following the initial bulb press conflicts with it and inhibits the perseverative bulb pressing.

Tikhomirov's closer analysis reveals that when the child is required to vocalize along with the bulb press, the bulb press itself takes longer than when no vocalization is required. Wilder (1973) discussing this data suggests that the same central processes may be involved in generating the two responses and that this may be responsible for the longer latencies. This suggestion implies that less "cognitive energy" is available for each of the responses thus demanding more time for the execution of either response. If this is true then the conflict between the two activities must be placed at the level of planning of the activities rather than at the level of the actual execution. This interpretation is also consistent with the present results since the planning

of the sentence in the covert sentence condition might be expected to be similar in demand for attention to the planning of the sentence in the overt sentence condition.

Unfortunately, latencies for the initiation of the motor activity are not available for the present study. These might provide further evidence with which the Wilder suggestion might be evaluated.

Conclusions

Two conclusions appear warranted on the basis of the present data. First, it is apparent that young children are capable of covert language production when given the appropriate instructions.

Secondly, the incompatibility of language production concurrent with motor activity is further demonstrated. The present results indicate that the extent of the conflict is greater than has been previously suggested.

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APPENDIX A

PAIR MEMBERS IN ORDER PRESENTED FOR LEARNING TRIAL

Pair members in order presented for learning trial

Stimulus	Response
Bird	Telephone
Rolling pin	Spider
Lion	Whistle
Cowboy	Pitcher
Hammer	Block
Turtle	Glasses
Key	Stove
Horse	Cup
Deer	Watch
Truck	Bottle
Clown	Guitar

APPENDIX B

SAMPLE SET OF INSTRUCTIONS

Sample Set of Instructions

Covert - Manipulation

We're going to play a game with some toys. I'll tell you how to play the game, OK? I'm going to show you the toys two at a time and each time I show you two toys, I'll tell you to make one toy do something to the other toy and at the same time make up a story about what they're doing. Can you do that?

Let's do one for practice.

Here's a boy and here's a boat. Make the boy do something to the boat while you tell me what they're doing.

[Give toys to child]

(If no response: What could the boy do to the boat?)

(If still no response: It could do something like this: "the boy goes for a ride in the boat.")

Second Example

I have a little stage here for the toys to do things in. I'm going to show you two more toys and this time I want you to make them do something in the stage and make up a story about what they're doing and keep your story a secret. Don't tell me what the story is, just think of it to yourself. OK? You can just put your hands under the curtains and I'll give you the toys.

Here's a screwdriver and here's a chair. Make the screwdriver do something to the chair while you think of a story about what they're doing but don't tell me yet. Did you think of a story? OK, for this time tell me what the story was.

Third Example

Let's do another one for practice. Here's an airplane and here's a racecar. Make the airplane do something to the racecar while you think of a story about what they're doing but keep the story a secret. Were you able to make up a story? Good, keep it a secret.

Presentation

OK. Now I'm going to show you a whole lot of toys two at a time and each time I show you two toys I'll tell you to make one toy do something to the other toy while you make up a story about what they're doing but keep your story a secret. Don't tell me what the story is.

1. Bird - Telephone — Make the bird do something to the telephone while you think of a story about what they're doing but keep the story a secret
2. Girl - Pipe — Make the girl do something to the pipe etc.
3. Rolling Pin - Spider
4. Lion - Whistle
5. Cowboy - Pitcher
6. Hammer - Block
7. Turtle - Glasses
8. Key - Stove
9. Horse - Cup
10. Deer - Watch
11. Truck - Bottle
12. Clown - Guitar

Very Good

Test

Now let's do something a little different. When I showed you all those toys just now I always showed you two toys at a time, Right?

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Let's see if you can remember which toys were together. I'll show you just one toy at a time now and you tell me which toy was with it. Can you do that?

Which toy was with the:

1. Key
2. Deer
3. Hammer
4. Turtle
5. Horse
6. Girl
7. Lion
8. Bird
9. Rolling Pin
10. Clown
11. Cowboy
12. Truck

Very Good

Now let's do one more thing. Remember when I was showing you the two toys at a time, you thought of stories about one toy doing something to the other toy. Now you can tell me the secret stories you made up. Let's see if you can remember the stories you thought of before. I'll show you the toys again and you tell me the same stories you thought of before. OK?

1. Bird - Telephone — Tell me the same story you thought of before about the bird doing something to the telephone
2. Girl - Pipe — Tell me the same story etc.
3. Rolling Pin - Spider
4. Lion - Whistle
5. Cowboy - Pitcher
6. Hammer - Block
7. Turtle - Glasses
8. Key - Stove
9. Horse - Cup

10. Deer - Watch

11. Truck - Bottle

12. Clown - Guitar

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